Risk Assessment Review

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Tree risk assessment is an important part of urban forest management and there are many tree owners and managers that are required to ensure their trees are maintained to an acceptable level of risk associated with them. Trees are living things, constantly changing and eventually dying, therefore there is always a certain level of risk associated with trees where trees and people interact.

Risk is defined as the likelihood of an event multiplied by the consequence (MIS 501 in draft). There are a number of risk assessment methods currently in popular use. Risk assessment methods are qualitative or quantitative, meaning they use either words or numbers respectively. This is a review of three of the most commonly used methods: TRAQ, QTRA, and VALID. The advantages and disadvantages of these 3 systems are discussed below.

RISK: the LIKELIHOOD of an event MULTIPLIED by the CONSEQUENCE.

Tree risk assessment training.

TRAQ

TRAQ was developed by Julian Dunster and others from the International Society of Arboriculture (ISA) in the United States. It is a purely qualitative system that describes the inputs and outcomes in words. TRAQ training began in Australia in 2013 and with another edition of its associated *Tree Risk Assessment Manual* released in 2017. It is widely used in Australia.

| ADVANTAGES	DISADVANTAGES
Words like low moderate and high are easy to understand and most people think they know what they mean. The use of matrices is they are uncomplicated and are easy to read. Many people are familiar with them and are comfortable using them. With only 4 categories to choose from there is likely to be a high level of consistency between different assessors.	The use of descriptive words to define the various categories is problematic because words mean different things to different people. What one person might consider to be high, another person might consider to be moderate and so on. The use of matrices is mathematically unsound. Indeed the TRAQ manual even says that the addition or multiplication of ordinal rankings is mathematically incorrect. TRAQ does that with its matrices. The categories used have poor range values. That is some ranges are very large and others are extremely small. So "Improbable" means close to a probability of 1/1,000,000 and the next category up is "Possible". This category has to cover everything from "Improbable" all the way up to greater than 1/2, a huge range. The use of the risk matrices categories means that because of the way they fit together a result can jump two levels with a very small change to one of the input categories. In Matrix 2 (Figure 1) a 'Somewhat likely' failure and impact and a 'Minor' consequence gives a 'Low' risk. However increase the failure and impact slightly to "Likely' and the consequence to "Significant' and the risk jumps to straight to High. Because of the vagueness of the meaning of the terms and the wideness of these ranges it is possible that very slight changes in the input can take the risk output from Low to High. The end result of this vagueness in the middle ranges of risk is that assessors more often feel the need to be conservative in their thinking and lean towards a higher risk outcome than the circumstances warrant.

LIKELIHOOD OF FAILURE & IMPACT	CONSEQUENCES OF FAILURE			
	NEGLIGIBLE	MINOR	SIGNIFICANT	SEVERE
VERY LIKELY	Low	Moderate	High	Extreme
LIKELY	Low	Moderate	High	High
SOMEWHAT LIKELY	Low	Low	Moderate	Moderate
UNLIKELY	Low	Low	Low	Low

Figure1: Matrix 2 from TRAQ shows the qualitative terms used in this method of Tree Risk Assessment.

TRAQ works well where the risk of harm is very high, or low. Because of the problems with the range values being too wide or too narrow when a risk is somewhere in the middle, TRAQ can give answers that don't make sense. It is in these middle ranges where a risk manager needs to have guidance as to what risk mitigation measures are required. The risk ranges, including "Low" all recommend some action to be carried out. This gives rise to the view that every situation needs some work to be carried out when clearly acceptable risks do not. A great deal of unnecessary tree removal and pruning may be occurring as a direct result of the use of TRAQ.

Unnecessary tree work may be exacerbated by the use of the term 'defect' to describe a tree feature. It has a pejorative connotation and even though the TRAQ workbook says that it doesn't necessarily mean it will mean an increase in likelihood of failure, people are likely to think it is so.

Throughout the manual many issues are raised and it is advised that they be considered when making the various assessments. It is difficult to understand with some issues, such as prevailing wind, how that information should be factored into the the assessment process as trees are self-optimising organisms and will have already dealt with effects such as wind. These issues are raised repeatedly and although it is often stated that they may have an effect, there is rarely, if ever, a discussion about the effects themselves. When dealing with co-dominant leaders for example, if a co-dominant leader has an included bark junction it may increase the likelihood of failure by an order of magnitude. That is from 1/10,000,000 (healthy tree with no major risk features) to 1/1,000,000 (still pretty good odds) but the manual wants to call the Probability of Failure (PoF) 'possible' or 'probable' which is a gross overestimation of the real PoF.
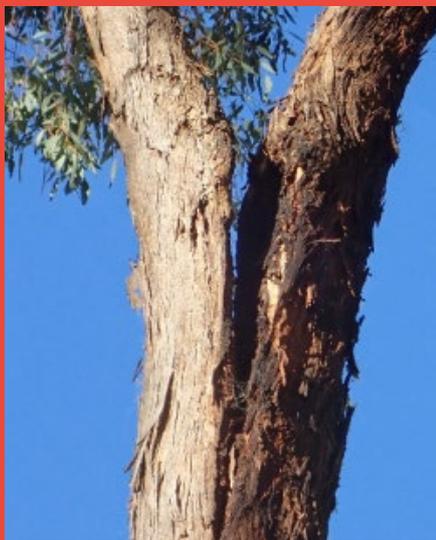
Defects or Tree Risk Features? Can the language we use impact outcomes of qualitative assessments?

QTRA

QTRA is owned, and was developed by, Mike Ellison from the UK. It was first released in Australia in the mid 2000's. It is a quantitative system that uses numerical inputs. The inputs are given in ratios and the resulting risk assessments are also given as a ratio. The risk of harm outputs that are generated are categorised as Broadly Acceptable, Tolerable or Not Acceptable but these are still related to numerical values. It is widely used in Australia, New Zealand, Europe and the UK.

ADVANTAGES	DISADVANTAGES
Risk is an inherently mathematical concept. Using numbers to describe the risk allows for clarity of meaning. The probability of 1/1 means the same thing to most people.	Many people are not comfortable with numbers and very small numbers can be very difficult to clearly understand.
The probability of risk of harm can be compared to benchmark numbers that are universally accepted rather than trying to derive meaning from words. For example where TRAQ describes "minor damage to a vehicle" that could vary hugely depending on whether the vehicle is new or old, expensive or cheap.	Working out the correct occupation values are can be very challenging. When carrying out these complex calculations it is easy to make a mistake and that mistake then carries on to the Risk of Harm output.
By assigning probabilities to the three inputs, and then multiplying them, the mathematical rigour of risk is maintained so you don't get any completely wrong answers.	The use of single figure probabilities gives a false sense of accuracy. There is no practical difference between 1/72,000 and 1/50,000 and few people can understand what that difference can mean.
There is an easily accessible forum available to users so that any questions around how to apply the method can be made to the whole QTRA community. This has been a very useful tool both for new users and for improving the system.	The size ranges used are problematic and do not appear to have been calibrated. The use of a 600 mm diameter branch or trunk as having a 1/1 probability is not borne out by the logic. The other size ranges are round numbers in terms of their size but then these give rise to very precise probabilities. It would be better to adjust the size ranges to give outcomes of probability that are in orders of magnitude.
	When areas of frequent use are being assessed such as busy city streets the occupancy may be actually more than 1/1. QTRA does not address this accept to use 1/(T) system which is very difficult to understand. For a tree manager it is usually impossible to take this information into consideration. A similar issue arises with multiple targets which are common in busy cities with the combination of traffic and people.
	Where an assessment is being made of these high occupancy situations the QTRA user will be underestimating the RoH by an order of magnitude.

QTRA has been updated and evolved over the time. Many of the major problems have been ironed out over the years. There has not been an update since version 5 was released many years ago and many changes have been in response to VALID procedures (e.g. Traffic light symbol identifiers).

The use of a calculating wheel and input ranges has reduced the difficulties of deciding what inputs are appropriate. The Risk of Harm has been divided into three main categories being Broadly Acceptable, Tolerable if as Low As Reasonably Practicable (ALARP) and Unacceptable. This has simplified the output and made it easier to understand for the tree managers. There seems to be little appetite to address the issues around the size of the part ranges and multiple targets and that is a concern for QTRA users.
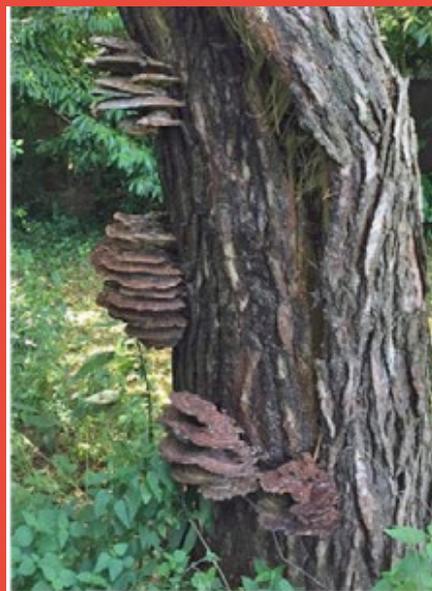
All tree risk assessment involves consideration of a number of risk factors, such as the presence of decay and fungi.

VALID

VALID is a not for profit organisation that was developed in the UK by David Evans. David had been part of the development of QTRA. VALID uses a mix of qualitative and quantitative inputs and provides a qualitative output. The actual assessment process is carried out by an App that works on a phone or pad. So the maths is done behind the scenes by the "black box". It was presented in Australia in 2018 and is used in the UK, New Zealand and Australia.

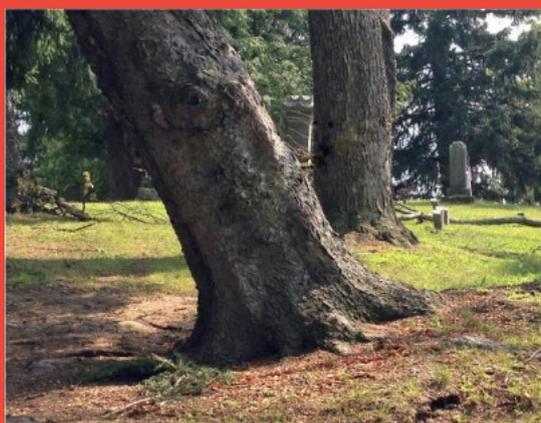| ADVANTAGES	DISADVANTAGES
The system uses an App that does the calculations so that VALID uses both words and numbers to describe the inputs. The App has been designed to use category widths that make sense mathematically and because the maths is being done behind the scenes the complexities of the system do not impact on the user. The outputs are given in four simple ranges that then inform the tree managers as to the appropriate action to take. VALID also provides an advisory note suitable for use by tree managers whether they are Local Government, or private landholders.	The underlying mathematics running the App have not been made available for peer review. VALID claims to have used the services of a respected and independent maths professor to develop and test the App but this must be accepted without any chance to review and criticise it. The risk of harm for incidents involving motor vehicles (not motor cycles) appears to be high. There is little evidence of people being killed from cars running into fallen trees but this still apparently has a significant input to the calculated risk of harm.

VALID is a relatively new system and is undergoing constant review and improvement. It appears to give sensible outputs and with the mandatory training, is simple to use. The system produces a report that can be provided to the tree manager simply by email.

VALID recognises that the reason for conducting a tree risk assessment is because the tree manager needs to manage the risk from trees. VALID has provided notes that are designed to be included in a report or given to the tree manager to help them understand how best to use the tree risk report provided.

VALID has gone to considerable trouble to deal with the shortcomings of the other available risk assessment systems and has attempted to use the best elements of both qualitative and quantitative systems. Care has also been taken with language used to reduce the bias produced by terms such as 'tree defects'. VALID uses 'tree risk features' instead.

VALID is continuously issuing guidance notes and discussions on subjects related to tree risk. For example the phenomenon of 'sudden branch drop' has been discussed and currently VALID has published notes explaining and describing the tree risk features associated with this phenomenon.

In my opinion, the ease of use for the risk assessor and the sensible outputs make VALID are attractive features of this tree risk assessment method.

All tree risk assessment methods have their advantages and disadvantages. It is important to know the limitations of each.

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